Median Nerve Injuries in Fractures in the Region of the Wrist

N. MEADOFF, M.D., *Bakersfield*

SUMMARY

Injuries of the median nerve in fractures in the region of the wrist are not uncommon.

Median nerve palsy is frequently the result of immobilizing the wrist in acute palmar flexion.

Good reduction and immobilization of the wrist in neutral position are the best means of preventing median nerve injury.

In any fracture in the region of the wrist, the status of the median, ulnar, and radial nerves should be examined before and after reduction of the fracture.

The majority of patients with median nerve neuritis recover completely without operation. In some cases, the duration of the sympathetic nerve paralysis is unpredictable.

Where neurological symptoms persist, neurolysis with or without sectioning of the transverse carpal ligament will improve the neurological status of the patient.

ALTHOUGH median nerve injuries are not infrequent complications in fractures of the wrist, standard texts on fractures either do not mention injuries of this kind or consider them to be extremely rare. For example, Key and Conwell[3] in discussing complications of fractures of the distal third of the radius, state that "very rarely with marked displacement the median nerve may be injured by the lower end of the upper fragment." However, Abbott and Saunders[1] felt that this complication is not so rare and should warrant more than a passing reference in a discussion of fractures of the wrist.

Since the first report of a case by Gensoul in 1836, 40 cases have been reported in medical literature. Within the last year and a half in private practice, the author has observed four patients with median nerve injuries and one with ulnar nerve neuritis in association with fractures in the region of the wrist.

REVIEW OF LITERATURE

In 1836, Gensoul reported the case of a young girl who died of tetanus following fracture of a forearm. At autopsy the median nerve was found to be caught between the ends of the fractured radius. Paget in 1854 cited a case in which the median nerve was involved in the excessive formation of callus around a fracture of the lower end of the radius. De Rouville in 1905 described a pseudoneuroma, three times normal size, of the nerve in the case of a 53-year-old man who developed a late median nerve paralysis following fracture of the radius. Blecher in 1908 collected reports of nine cases from the French literature and added one of his own. Kirchheim in 1910 collected reports of four more cases from the German literature. A basic review of the subject was made by Abbott and Saunders in 1933.[1] They presented reports of eight new cases. In 1945 Zachary reported two cases of compression of the median nerve within the carpal tunnel associated with old bony derangements at the wrist.[5] Eight similar cases were reported by Cannon and Love in 1946.[2]

THE ANATOMY OF THE MEDIAN NERVE AT THE WRIST

Abbott and Saunders gave the following description of the regional anatomy involved in this discussion:

The anatomical considerations of the median nerve at the wrist joint are of particular importance in explaining the special features and types of involvement which are met with when this nerve is injured in Colles' fractures. The nerve is not directly related to the volar surface of the radius but is separated from it by the fleshy mass of the pronator quadratus muscle and by the tendon of the flexor pollicis longus muscle. The pronator quadratus muscle serves to protect the nerve from fragments of this bone. At the wrist joint the nerve becomes superficial and lies on the ulnar side of the tendon of the flexor carpi radialis; behind or on the radial side of the palmaris longus. Just before passing into the hand, deep to the transverse carpal ligament, it often assumes such a superficial position as to be readily palpable. At this point the nerve gives off its palmar cutaneous branch which supplies the proximal part of the palm of the hand with sensation. Passing deep to the transverse carpal ligament and over-lapped by the lateral part of the synovial flexor sheath, it enters the palm and divides into medial and lateral divisions. Through the medium of these two divisions the nerve supplies the muscles of the thenar eminence, two or more lumbricals, and the lateral three and one-half fingers with sensation on their palmar aspect, and on their more distal part of the dorsal aspect. This area of sensory supply is subject to considerable individual variation, for the median nerve anastomoses to a variable extent with the ulnar and sometimes radial nerves, connections which may explain the variability in both motor and sensory findings.

It is of the greatest importance to remember that the median nerve carries with it most of the sympathetic nerve supply of the hand, an anatomical fact associated with frequency of trophic disturbances found when this nerve is injured.[1]

Presented before the Section on Industrial Medicine and Surgery at the 77th Annual Meeting of the California Medical Association, San Francisco, April 11-14, 1948.

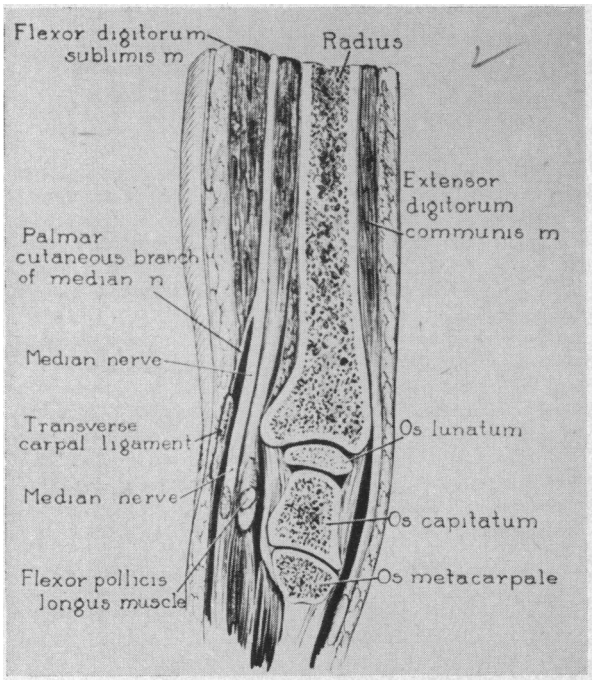

Figure 1.—Sagittal section to illustrate the relation of the median nerve in the region of the wrist. Note the close relationship which the transverse carpal ligament and the prominent lower anterior border of the radius bear to the median nerve. (Used by permission of *Surgery, Gynecology and Obstetrics.*)

CLASSIFICATION OF THE MEDIAN NERVE INJURIES IN FRACTURES IN THE REGION OF THE WRIST

In the same review these observers classified median nerve injuries as follows (I) Primary injuries. (II) Secondary injuries. (III) Late or delayed involvement. (IV) Injuries associated with treatment: (a) acute palmar flexion; (b) reduction.

The author suggests that the fourth category be enlarged to include median nerve paralysis associated with treatment and reduction of the fracture.

PRIMARY INJURIES TO THE MEDIAN NERVE

An injury to the median nerve occurring at the moment of fracture is classified as a primary injury. Because of the protection afforded by the pronator quadratus muscle, the majority of injuries develop indirectly from the pressure of a grossly displaced fragment.

The injuries most likely to fall into this group are those associated with carpal fractures and dislocations. Injury of that type is illustrated in the following case report:

CASE 1.—The patient, a 26-year-old white male, was injured May 27, 1948, when the motorcycle on which he was riding was struck by an automobile. The essential findings were: severe comminution of the olecranon, anterior dislocation of the elbow, transcarpal dislocation with fracture of the navicular, and sensory paralysis of the median nerve. There was no motor paralysis. An open reduction and plating of the olecranon was done; the transcarpal dislocation was reduced, and a cast was applied.

On July 13, 1947, when the cast was removed, sensory loss and dryness of the skin were confined to the area of distribution of the median nerve of the hand.

On September 11, 1947, under local anesthesia, the median nerve was exposed. No adhesions were noted. On injecting the nerve with saline, a constriction was evident at the level of the transverse carpal ligament. The nerve was followed into the carpal tunnel without sectioning the transverse carpal ligament. The day following operation, sensation in the thumb was normal. Five weeks later, sensation was normal in the hand, but the skin was still dry. The dryness of the skin was still present at the time the patient was last examined, February 14, 1948.

SECONDARY INJURIES TO THE MEDIAN NERVE

Injuries to the median nerve occurring within two months following fracture are arbitrarily considered secondary median nerve injuries. Most injuries that fall into this category are characterized by gradual development of both subjective complaints and objective findings. In the majority of cases, neuritis develops from continued pressure on the nerve by an unreduced fragment or excessive formation of callus.

Abbott and Saunders[1] reviewed Hilton's report of a case in which the median nerve was compressed from the excessive callus in the lower end of the radius. They also reported the case of a 47-year-old man in which a fracture of the wrist was not reduced because of the patient's cardiac status. Four weeks after the injury, numbness developed in the thumb and index finger. These symptoms were relieved by neurolysis of the median nerve two months after the injury. Following is an additional report of a case of secondary median nerve injury:

CASE REPORT

CASE 2.—A 39-year-old white female who was referred for consultation, in a fall had received a fracture through the distal third of the radius. A cast had been applied without manipulation. The wrist was immobilized in neutral position. Two weeks after the injury, numbness developed in the thumb, index, and middle fingers. There was no muscle weakness. Sensory hypesthesia corresponding to the distribution of the median nerve was noted. The patient recovered completely without treatment four months after the injury.

LATE OR DELAYED MEDIAN NERVE PARALYSIS

Late, delayed, or tardy median nerve paralysis refers to cases in which the paralysis occurs later than two months following injury. Such cases were reported by Paget in 1865, by De Rouville in 1905, by Lewis and Miller,[4] who in 1922 cited a case observed by Phemister, by Abbott and Saunders[1] in 1933, by Zachary[5] in 1945, and by Cannon and Love[2] in 1946. Onset of paralysis in those cases varied from three months to 18 years after injury.

None of the cases observed by the author falls into this group.

ACUTE PALMAR FLEXION

Abbott and Saunders called attention to the importance of the position of acute palmar flexion following the reduction of a fracture in the development of median nerve neuritis. Of particular interest was the observation that the neuritis seemed to develop consistently in cases in which osteotomy

was done to correct malposition of the radius. In such cases the surgical trauma and the acute palmar flexion both tended to narrow the space between the radius and the transverse carpal ligament. Resultant pressure of the transverse carpal ligament on the median nerve was responsible for the clinical picture. It is scarcely necessary, therefore, to emphasize that in performing osteotomy for malposition in the distal third of the radius, the position following operation should be sufficiently stable to allow immobilization of the wrist in neutral position. The following case report will serve to illustrate:

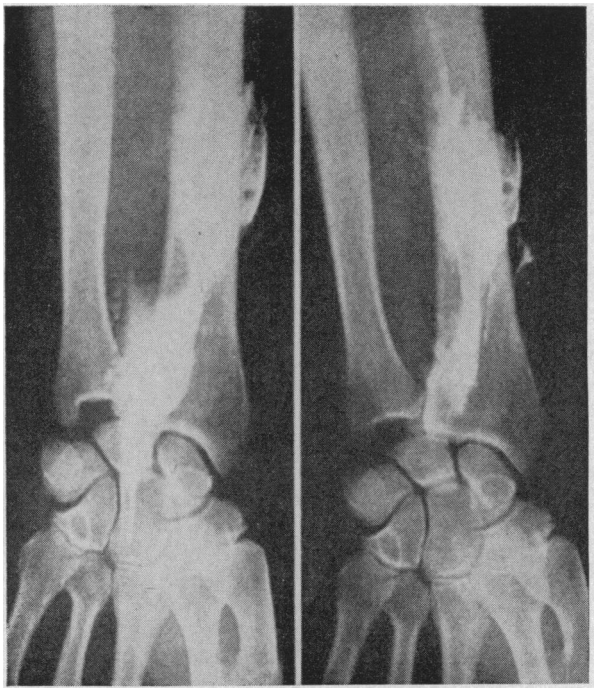

Figure 2.—Left, roentgenogram after injection of the sheath of the median nerve with lipiodol with the wrist held in extension. In this position the solution flowed freely into the palm of the hand. Right, roentgenogram after injection of the sheath of the median nerve with lipiodol with the wrist held in acute palmar flexion. The solution is arrested at the level of the transverse carpal ligament. (Used by permission of *Surgery, Gynecology and Obstetrics*).

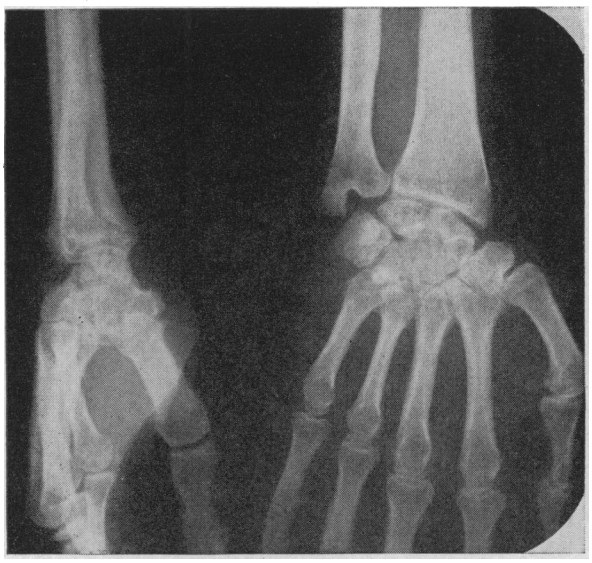

Figure 3.—Case 1. Transcarpal dislocation with an immediate median nerve injury.

CASE REPORT

CASE 3.—A 48-year-old woman who was referred by an insurance company two and a half months after fracture of the left wrist, stated that the fracture had been reduced immediately after the injury and the wrist immobilized in acute flexion in a cast. There was at that time, the patient said, immediate severe swelling of the hand and numbness of the thumb, index, and middle fingers.

Upon examination, dryness of the skin on the volar aspect of the thumb, index and middle fingers was noted, with sensory hypesthesia corresponding to the same area. The fingers were stiff, and flexion brought them only to an inch from the palm.

Three months later, normal sensation had returned, and within ten months all evidence of median nerve paralysis had cleared except for dryness of the skin on the palmar aspect of the index finger.

INJURIES ASSOCIATED WITH TREATMENT

The following case illustrates paralysis of the median nerve following repeated attempts at reduction of the fracture:

CASE REPORT

CASE 4.—A seven-year-old boy was referred a month after a fracture of both bones of the forearm had been reduced. Roentgenograms in the cast showed the wrist to be in slight palmar flexion and there was contact of the fractured ends of the radius through one-half of the shaft. In roentgenograms taken ten days later, complete displacement of the fracture was noted. The day before the patient was referred, the physician referring him had made repeated but unsuccessful attempts at reduction of the fracture.

Upon examination, prior to manipulation of the fracture, loss of opposition of the thumb was noted, together with weakness of flexion of the distal phalanx of the thumb and index finger, and sensory anesthesia corresponding to the distribution of the median nerve. The skin was dry in the same area. Satisfactory reduction of the fracture was obtained and the wrist was immobilized in neutral position. A month later sensation was normal and opposition of the thumb had returned, but the skin was still dry.

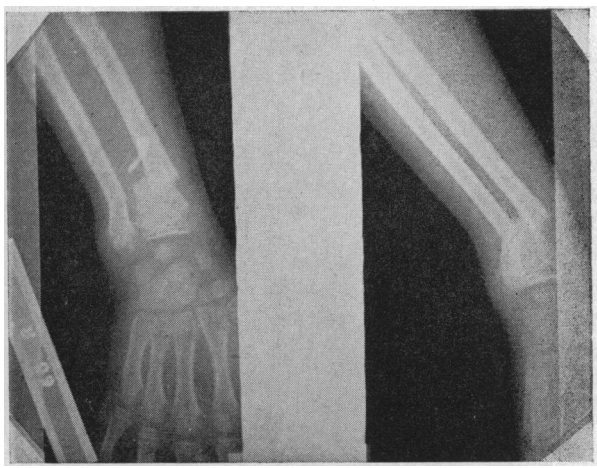

Figure 4.—Case 4. Median nerve injury developed during manipulation.

DISCUSSION

As poor functional return and prolonged disability are common after fractures in the distal third of the radius which are accompanied by severe swelling of the fingers, more attention should be given to numbness of the fingers which is frequently noted in connection with these symptoms, for this is probably the result of nerve compression. Anatomically, it has been demonstrated that the position of acute palmar flexion causes a narrowing of the space between the radius and the transverse carpal ligament. The presence of hematoma and the swelling accompanying both the fracture and the trauma caused by manipulation would further tend to narrow the space and thus increase the possibility of median nerve compression. This mechanism explains the majority of cases of primary median nerve injuries.

Except for the comment by Speed in discussing the paper by Lewis and Miller[4] in 1922, scant attention has been paid to median nerve injuries due to transcarpal dislocations of the wrist. Median nerve neuritis as a result of transcarpal dislocation was illustrated in Case 1. The median nerve can also be injured more directly during manipulation, especially in cases of fracture of both bones of the forearm in children. Reduction of such a fracture is most easily accomplished by hyperextension at the site of the fracture; but it should be noted that the median nerve can be stretched or contused during manipulation. The same mechanism could be responsible for injury to the median nerve in the treatment of Colles' fractures where the deformity is increased to break up an impaction, as is advocated in many textbooks. Case 4 demonstrates this type of injury to the median nerve.

The development of neuritis in both median and ulnar nerves many years after a fracture has healed in poor position is a complication which needs greater recognition. In the literature are reports of cases in which neuritis of this kind occurred from two months to 20 years after the injury.

DIFFERENTIAL DIAGNOSIS

The neurological literature contains frequent mention of thenar muscle atrophy, usually without accompanying sensory disturbance. No causative factor has been found. This has been labelled "thenar muscle paralysis" and it is differentiated from median nerve injuries in fractures mainly by the absence of bony changes in the wrist or forearm.

TREATMENT

Median nerve neuritis can best be prevented by good reduction of the fracture and immobilization of the wrist in neutral position. If symptoms of neuritis develop immediately after reduction, correction of the palmar flexed position is indicated at once. If symptoms persist after four months, surgical exploration of the median nerve is advisable.

Whatever the cause of the neuritis, neurolysis or neurolysis with sectioning of the transverse carpal ligament will arrest or cure the disability in the majority of cases. The improvement in neurological function following operation has varied with the degree of severity of the neurological status. The more complete the nerve palsy present, the less recovery occurs.

1730 D Street.

REFERENCES

1. Abbott, L. C., and Saunders, J. B. de C. M.: Injuries of the median nerve in fractures of the lower end of the radius, Surgery, Gynecology, and Obstetrics, 57:507-16 (Oct.), 1933.

2. Cannon, B. W., and Love, J. G.: Tardy median palsy; median neuritis; median thenar neuritis amenable to surgery, Surgery, 20:210-16 (Aug.), 1946.

3. Key, J. A., and Conwell, H. E.: The management of fractures, dislocations, and sprains, St. Louis, the C. V. Mosby Co., 1942.

4. Lewis, Dean and Miller, E. M.: Peripheral nerve injuries associated with fractures, Trans. Am. S. A., 40:489-580, 1922.

5. Zachary, R. B.: Thenar palsy due to compression of the median nerve in the carpal tunnel, Surgery, Gynecology, and Obstetrics, 81:213-217 (Aug.), 1945.

Discussion by LLOYD D. FISHER, M.D., *Oakland*

Dr. Meadoff is to be commended for emphasizing the occurrence of median nerve damage in injuries about the wrist. By adding to the number of reported cases he indicates that such injuries are probably far more frequent than has generally been supposed. This complication is especially important because of the fact that loss of the power of opposition of the thumb is extremely disabling.

We might ask why this complication has been so frequently and commonly overlooked. Some of the reasons may be as follows:

1. The fracture of bone receives major attention and concern, and other injuries, unless quite obvious, are apt to be overlooked.

2. Failure to recognize that median nerve injury is a not infrequent complication of wrist injuries.

3. Difficulty in evaluating neurological changes in the presence of the symptoms and findings of acute fracture.

4. The very frequent variability in motor and sensory supply of the median nerve.

I am afraid that some of us, in our haste and in our concern over the bony injury, have forgotten one of the fundamental teachings of fracture treatment: That careful examination should be made for evidence of nerve and vascular damage in every fracture.

It is well to remember that the motor supply of the first two lumbricals comes by way of the terminal cutaneous branches of the median nerve. Also, it bears repeating that no matter what variations occur in the nerve supply, sensory changes in the index finger are a sure indication of median nerve damage. In secondary or delayed cases, sudomotor change in the skin is important confirmatory evidence.

Most important of all, I believe, is the emphasis on prevention of median nerve damage. To be sure, nothing can be done in a preventive way about primary nerve damage. We can, however, by proper treatment, avoid or minimize later damage.

In general, as Dr. Meadoff has pointed out, good reduction, proper immobilization, and, later, proper mobilization are all-important. Specifically such prevention should consist of:

1. Avoidance of hyperextension of the fracture during reduction.

2. Accurate reduction by restoring the dorsal, radial, and rotary displacement of the distal fragment, adding the least possible amount of trauma in so doing.

3. Avoiding immobilization in the hyperflexed position.
4. Maintenance of reduction by proper immobilization.

The immobilization in a neutral position advocated by Dr. Meadoff is ideal if one is able to maintain reduction in that position. Personally, however, I have not been able to consistently maintain reduction in the neutral position.

Some of the remarks of Sir Reginald Watson-Jones are very pertinent in this regard. In regard to sources of disability in Colles' fracture he says: "In a very few cases, the backward displacement stretches the nerve over the front of the wrist and transient median neuritis develops, with tingling and numbness of the fingers and weakness of the thenar muscles."

As to manipulative reduction, he states: "The fragments should not be disimpacted by increasing the backward displacement because this increases the injury to already bruised tissues over the front of the wrist. There is no difficulty in completely disimpacting the fracture by strong traction applied to the fingers and thumb. When this has been done, reduction of the displacement must be completed by direct pressure over the fragments."

Regarding immobilization after reduction he says, in part: "The carpus and lower fragment are pushed inward and forward. There is no need to flex the wrist strongly, and the Cotton-Loder position should be avoided."

Discussion by J. B. de C. M. SAUNDERS, M.D., *San Francisco*

Dr. Meadoff has rightly emphasized that injuries to the median nerve in fractures in the region of the wrist are a not infrequent complication which is frequently overlooked. That injury to this nerve in greater or lesser degree is not uncommon is indicated by the fact that within the year following the initial publication by Dr. Abbott and myself we encountered no less than 19 additional cases. It is true that in the vast majority of these cases the nerve damage was incomplete and the symptoms very transient but in one or two the damage was of sufficient magnitude to demand neurolysis. In most instances, the loss was purely sensory and seldom was motor power affected.

We feel that in all cases of fracture of the lower end of the radius the surgeon should carry out a meticulous examination in order to determine the presence or absence of median nerve involvement before reduction is attempted. In this connection, it is most interesting to note Dr. Meadoff's observation that the median nerve may be traumatized by hyperextension at the time of reduction. I am sure that this is possible, but to be truthful, the mechanism had not occurred to me. We should also like to emphasize the point that excessive palmar flexion as a position of fixation is a frequent cause of injury to the nerve, for in this position it may be pinched between the bony prominences and the proximal edge of the transverse carpal ligament. If it is found necessary to use a position of exaggerated palmar flexion for fixation, frequent examinations of the sensory and motor supply of the thumb and index finger should be made in order to avoid possible injury to the nerve, which, as we have noted, may lead to a degree of permanent loss of the function of the hand.

I wholeheartedly agree with Dr. Meadoff that this is a far more frequent complication than the textbooks would lead one to believe.